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M. Weiss/K. Zimmermann/ M. Braunschweig/P. Walkling/M. Jahn/S. Lerm

RoboCup-Player "LUKAS" – an object of interdisciplinary research and a benchmark problem in mechatronics

PC-BASED CONTROL

0. Introduction

The department of Computer Applications in Engineering and the department of Technical Mechanics of the Faculty of Mechanical Engineering at the Technical University of Ilmenau are currently working on the creation of a RoboCup team. Initiated by the students in 2000 wheeled robots for the small sized league have been developed. These robots are autonomous with a maximum diameter of 180mm and are controlled by an image processing system together with a central PC.

1. Design of the mobile robot (hardware)

At first the concept of a two wheeled robot with differential drive was developed in Ilmenau. At the moment the team is working on the realization of an improved system with three omnidirectional wheels (Fig. 1). These wheels provide the ability to move the robot in the direction of the wheel axis. The control (hard- and software), image processing, construction and the technical realization have been done solely by students and staff of the Faculty of Mechanical Engineering.

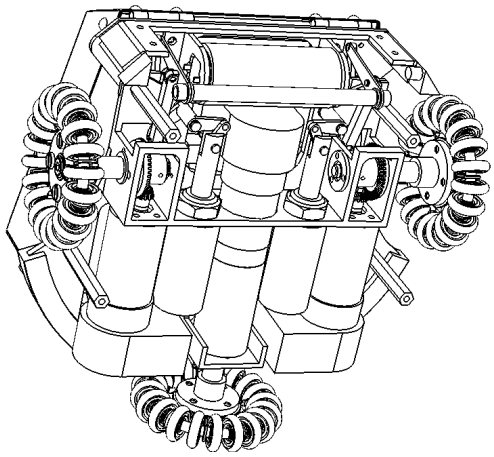

Fig. 1: The Robocup player „LUKAS"

2. Image processing and control system (software)

The system has to solve different tasks when you play robot soccer according to the RoboCup rules. To make several robots play as a team you have to coordinate common actions. Therefore a complex planning is necessary. This planning has to be adjusted to each robot and its situation on the playing field. You need some parameters for a precise planning. These parameters are the position and the orientation of the robot and the robot-ID. The position of the ball is also very important. If you know the position of the players of the opponent team, you can plan more complex manoeuvres. The parameters of the robots in the RoboCup Small-size-League are determined by image processing. For this purpose different coloured markers are placed on the top of each robot. These coloured markers are filmed by a camera above the centre of the field. The signals of the camera are analysed by a controlling computer and the parameters of the robots are

determined. With these parameters it is possible to plan the action of each robot from one team. The robots receive their commands via radio signals. A microcontroller in the robot analyses the commands and converts them into a control voltage for each engine of the robot. The paper deals with the determination of the parameters of the robots by analysing the pictures made by the camera. For this purpose a new coloured marker for the top of the robot has been developed which is scanned for by the camera. At first the pictures are classified with a maximum-likelihood-classifier into eight colour classes within the RGB colour space. The likeliness is calculated with the Mahalanobis distance. Then the pictures are segmented with a modified line coincidence method that can handle colour pictures.

Finally a model is presented to identify the parameters of the robot. The implementation is done with a C++ computer program that can handle 50 pictures per second and detect objects with a velocity up to 2 m/s.

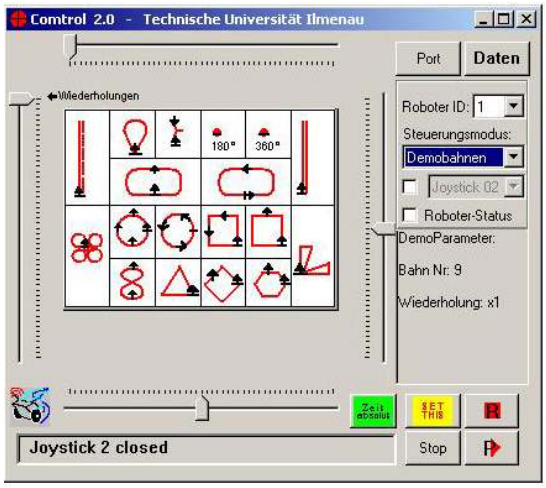

Fig. 2: Path planning via control system

The control system, which consists of a client server architecture allows a continuous path control of the robots (Fig.2).

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Authors:

Univ.-Prof. Dr.-Ing. habil. M. Weiss
Univ.-Prof. Dr.-Ing. habil. Klaus Zimmermann
Dr.-Ing. M. Braunschweig
Dipl.-Ing. (FH) H.-P. Walkling
Dipl.-Ing. M. Jahn
Dipl.-Ing. S. Lerm
TU Ilmenau, Fakultät für Maschinenbau, PF 10 05 65
98684 Ilmenau
Phone: +49 3677 692478
Fax: +49 3677 691823
E-mail: mathias.weiss@tu-ilmenau.de